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INDOOR MEASUREMENT OF ANGLE RESOLVED LIGHT ABSORPTION BY ANTIREFLECTIVE GLASS IN SOLAR PANELS

Mekbib W. Amdemeskel¹, Gisele A. dos Reis Benatto¹, Nicholas Riedel¹, Beniamino Iandolo², Rasmus S. Davidsen², Ole Hansen², Peter B. Poulsen¹, Sune Thorsteinsson¹, Anders Thorseth¹, Carsten Dam-Hansen¹

¹Department of Photonics Engineering, Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark

²Department of Micro- and Nanotechnology, Technical University of Denmark, Ørsted's Pl., 2800 Kongens Lyngby, Denmark

Introduction

The effect of the angle of incidence (AOI) on the optical properties of the cell is considerable for AOI larger than 45° and needs to be taken into account when assessing performance of solar cells, including the antireflective (AR) glass.

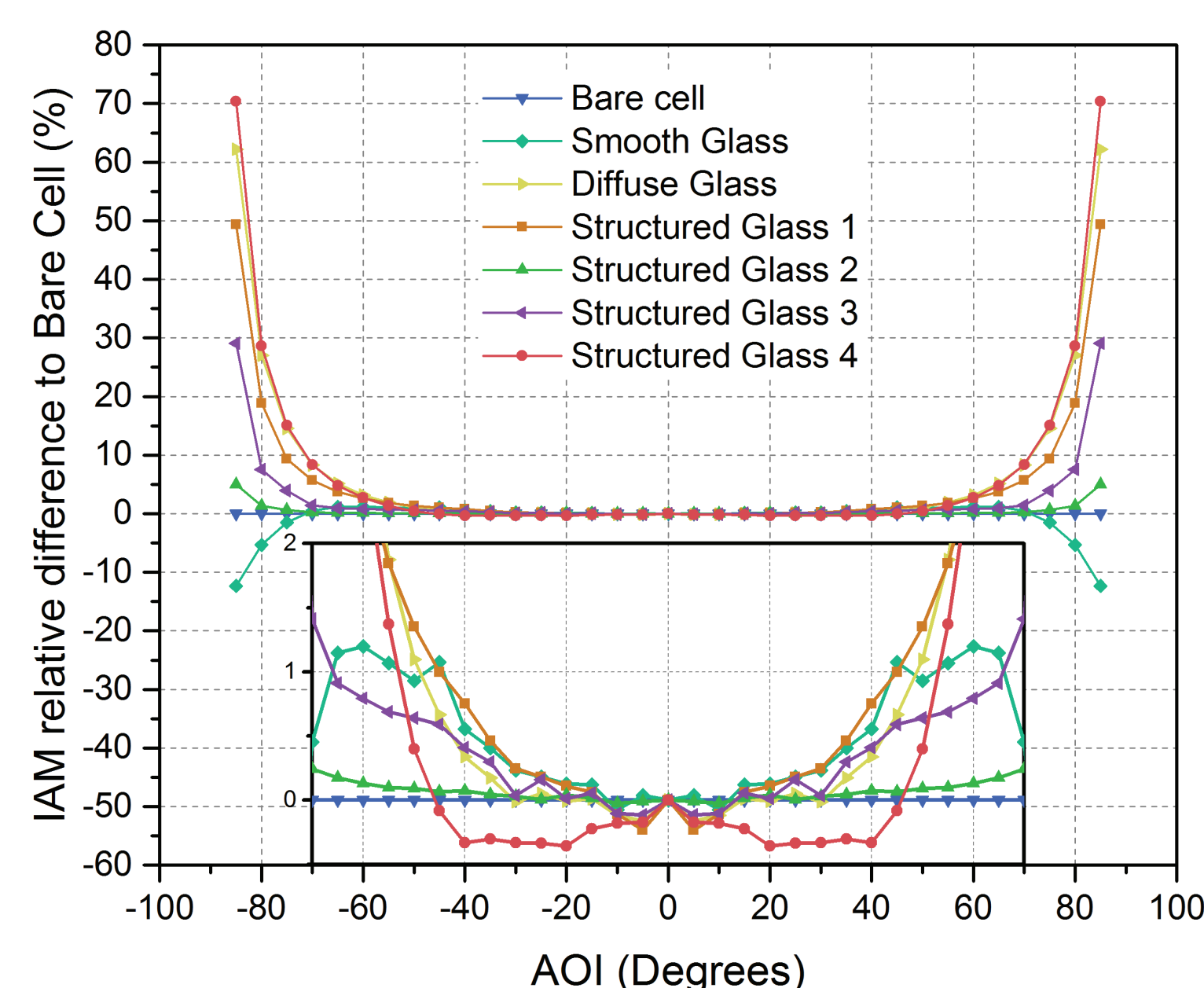
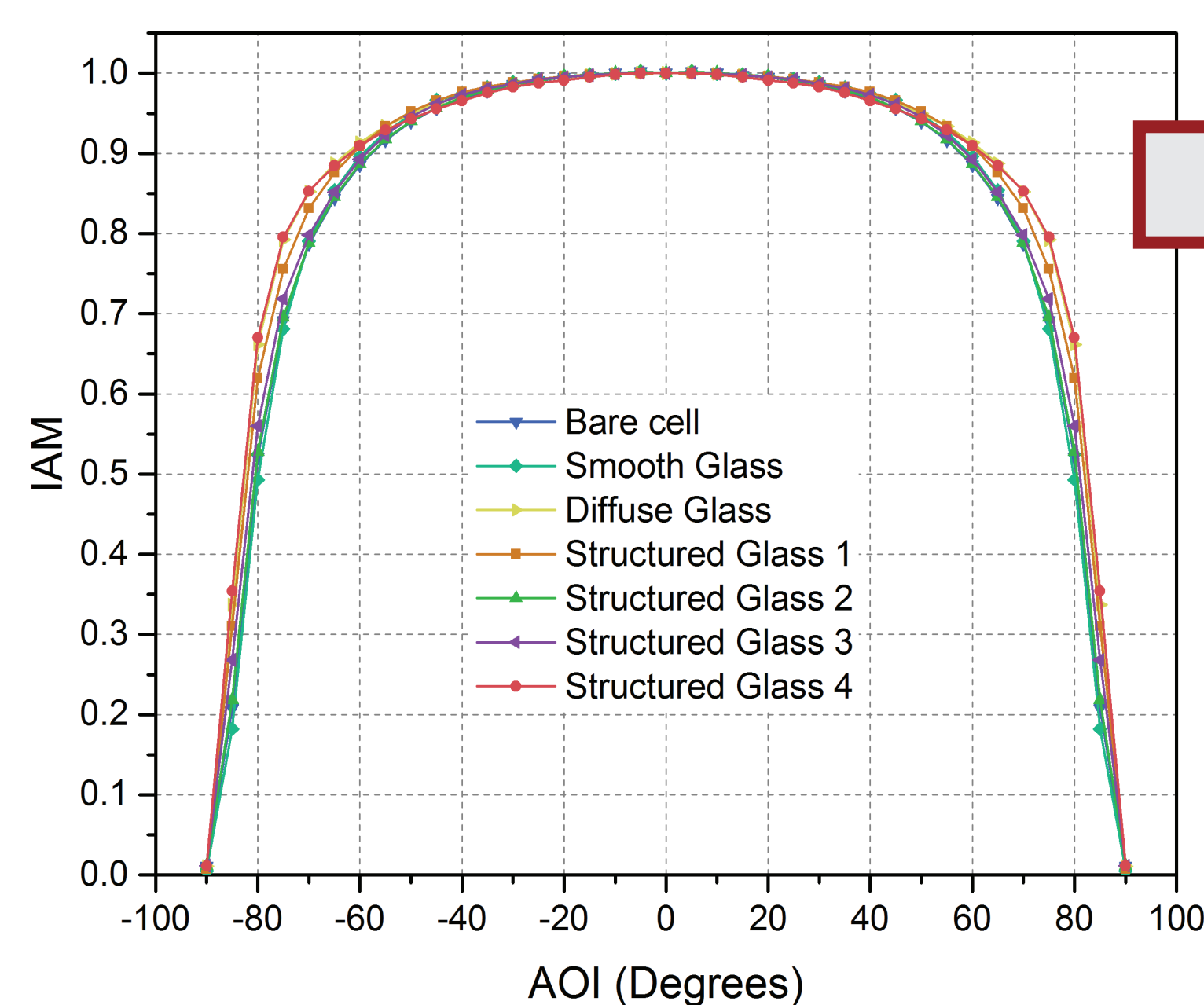
In this work, we normalize the relative short circuit current to a cosine response thereby isolating the optical effect of the glass-air interface. This form of data presentation is frequently described as the "incidence angle modifier" (IAM) and is used in PV modelling programs such as PVsyst.

Results

After I_{sc} - AOI measured:

- Area correction for angles $>\pm 75^\circ$
 - Normalized to AOI = 0°
- } IAM

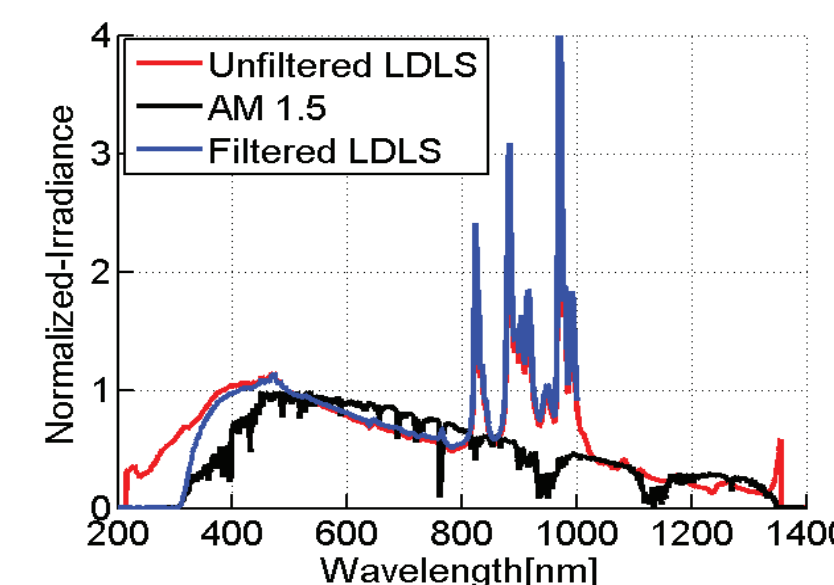
Since we used a collimated light source, we neglected the diffuse component.



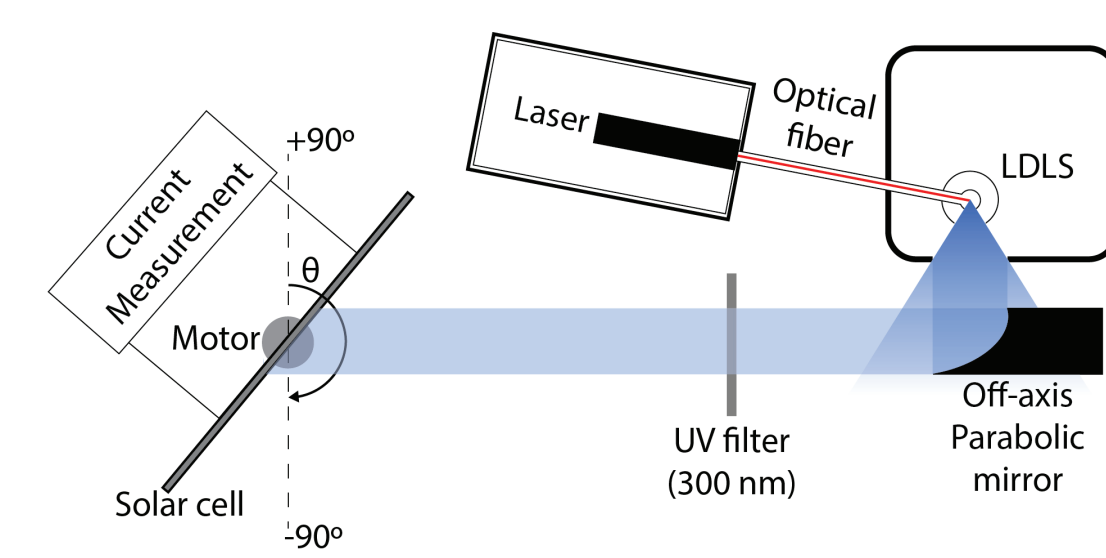
Experimental Method

A laser driven light source (LDLS):

- Off-axis parabolic mirror for collimation
- Angular divergence of about 0.1°

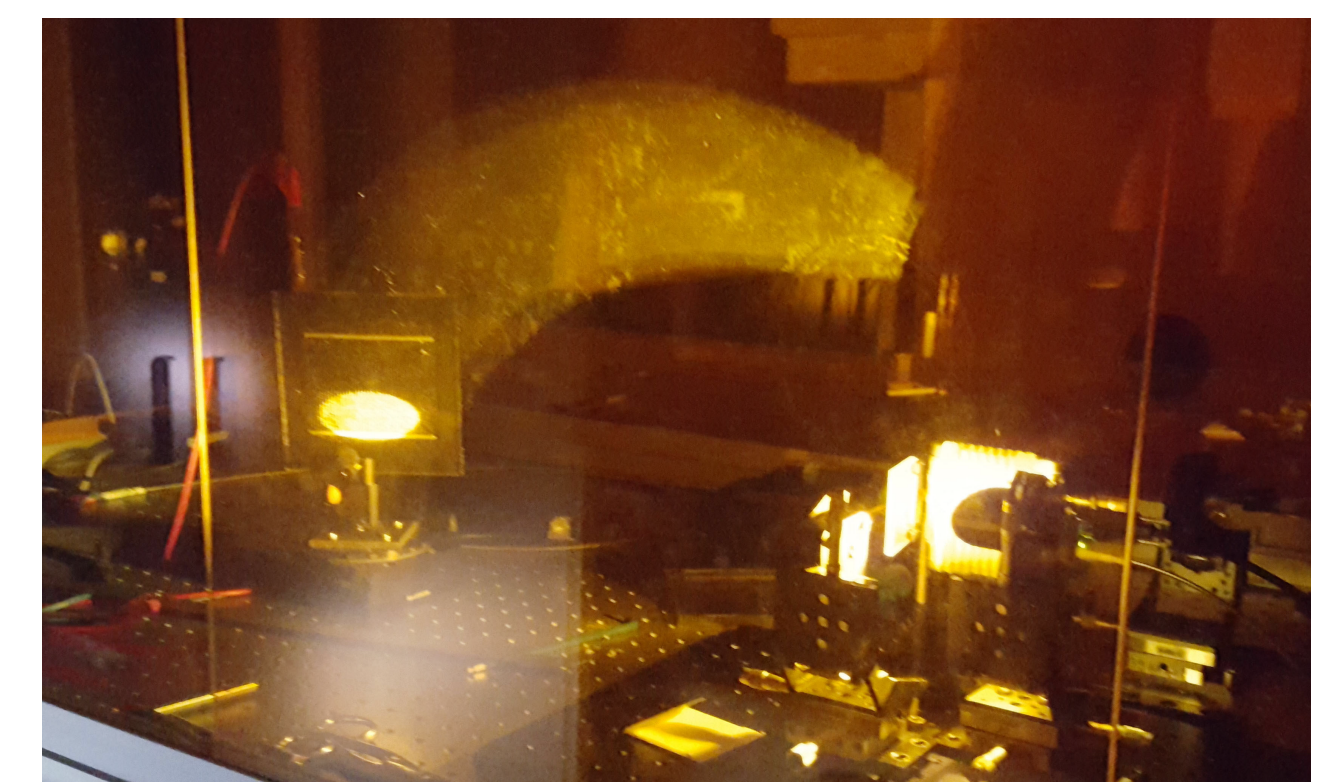


Setup Top view Schematic

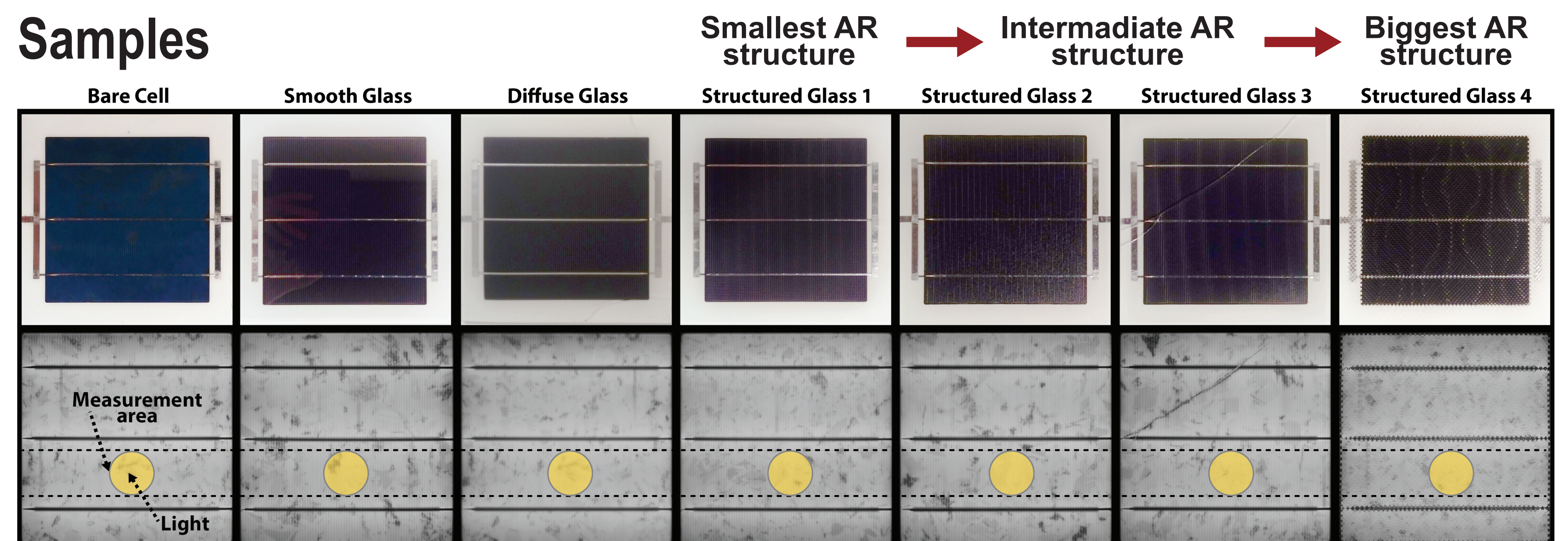


- Sample holder stepper motor
- Short circuit current (I_{sc}) measuring transducer.

Setup Photography



Samples

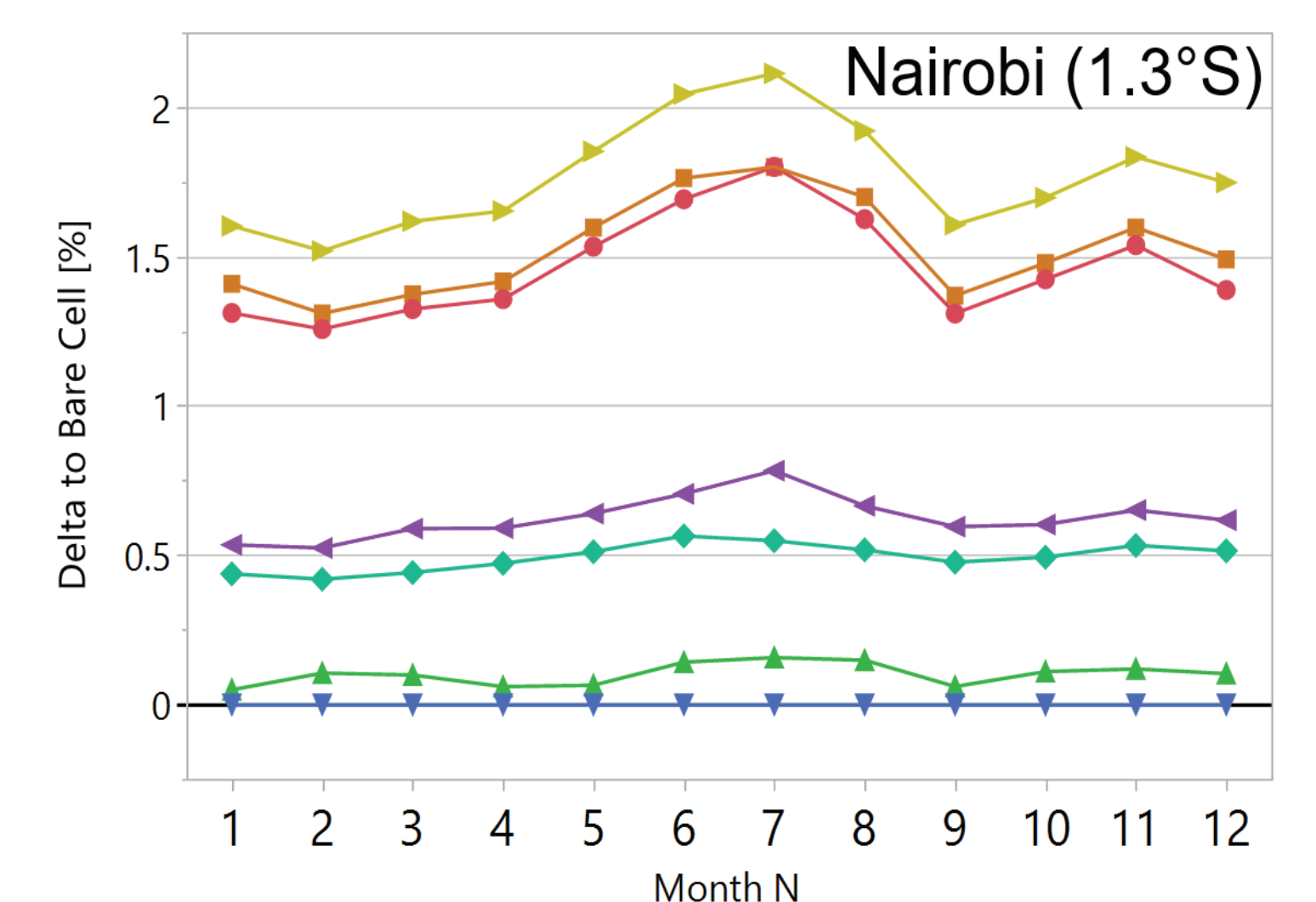
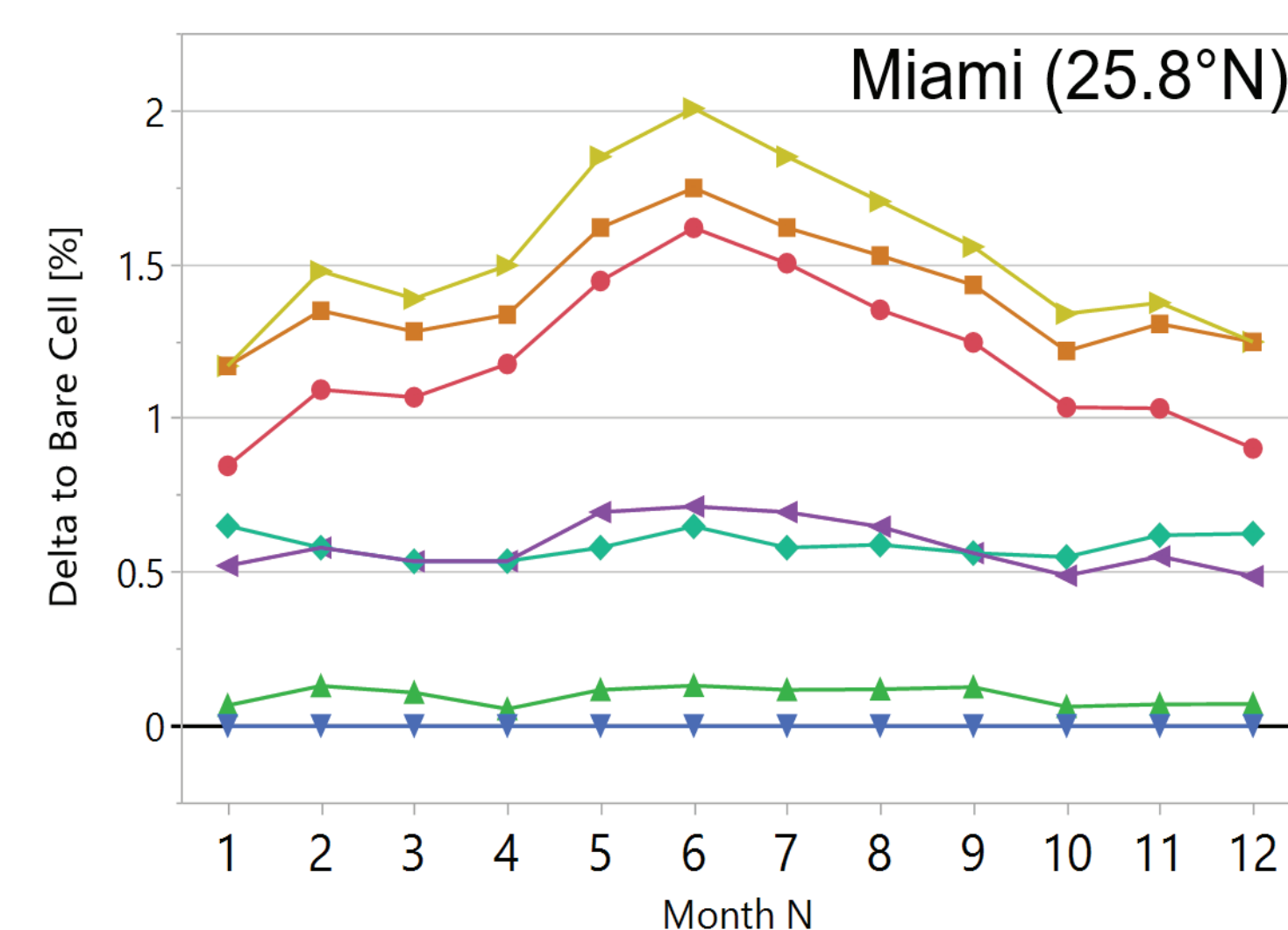
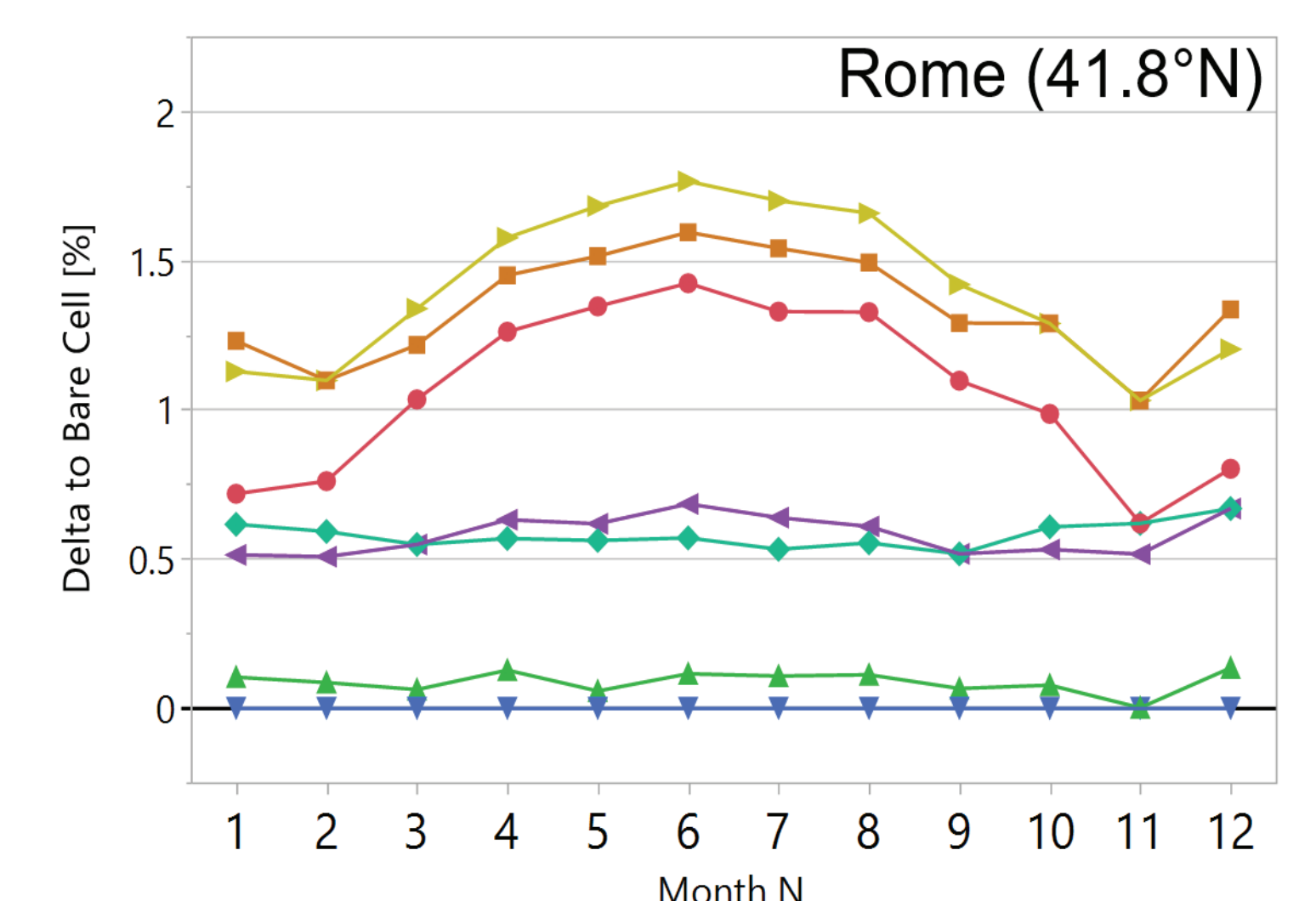
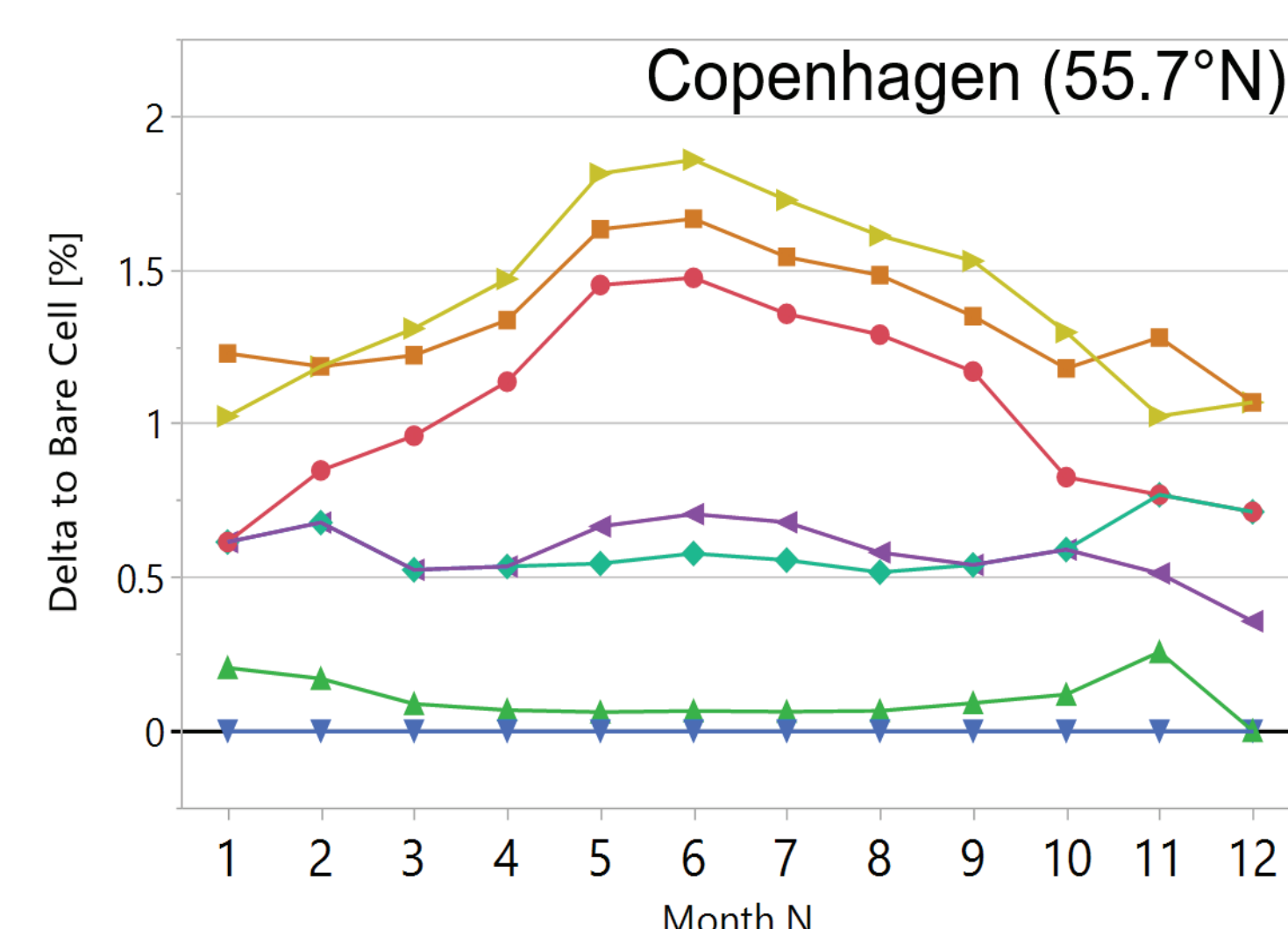


Simulations

- IAM data were used to create unique PV module files in PVsyst.
- Energy production of a 10 kWpeak grid-tied system.
- The locations selected so as to span a variety of latitudes.
- PV balance of system (BOS) was also kept constant in all simulations.
- A fixed-tilt rack relative to a horizontal plane was equivalent to the location's latitude.

- Bare cell
- Smooth Glass
- Diffuse Glass
- Structured Glass 1
- Structured Glass 2
- Structured Glass 3
- Structured Glass 4

Summary of monthly DC energy production estimates when the seven glass types are used across four locations.



Conclusions

- The results indicated that the different AR glasses present diverse optical effects from angles intervals between 0 – 45° and 60 – 90°.
- PVsyst simulations showed that Diffuse Glass sample can improve monthly yields by as much as 2% relative to Structured Glass 2 sample.
- Based on the PVsyst simulations, we consider the setup presented a valuable tool for indoor measurements of the IAM i.e. the angular performance on solar cells and mini modules.

Outlook

- Round Robin between other laboratories with AOI cell testing indoors and outdoors, for a comprehensive setup validation.
- Modelling of different glass types on BIPV systems, where the installed tilt angle does not allow for receiving the optimal amount of solar irradiance.

References

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